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Food Habits of Black Crappies, White Crappies, Yellow Perch and White Suckers in a Small Impoundment in Northeastern South Dakota

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FOOD HABITS OF BLACK CRAPPIES, WHITE CRAPPIES, YELLOW PERCH AND WHITE SUCKERS IN A SMALL IMPOUNDMENT IN NORTHEASTERN SOUTH DAKOTA

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree Master of Science, and is acceptable as meeting the thesis requirements for this degree, but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Labolt Pond view toward dam

Labolt Pond view toward inlet

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Abstract

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Crustaceans, aquatic insects and fish were the most important food items found in stomach samples.

Black crappies depended on zooplankton and aquatic insects as their major food source as they occurred in all samples and were major food items in 70 percent and 40 percent respectively.

Insects, zooplankton and fish were the major food items of white crappies. Insects were the dominant forage present in 54 percent of the samples while zooplankton and fish were dominant in 36 percent and 21 percent of the samples respectively.

Perch relied on crayfish, fish and aquatic insects as their major food source. Aquatic insects and crayfish each were the dominant food item in 33 percent of the samples while fish were dominant in 25 percent.

Microcrustaceans were the major food item in 75 percent of white suckers with detritus the dominant item in 25 percent.

Young-of-the-year fish fed totally on zooplankton with the exception of largemouth bass which occasionally took aquatic insects.

Black crappies and white crappies strongly selected Daphnia spp. White suckers did not exhibit a distinct pattern in the selection of Cladocerans.

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DGU

INTRODUCTION

Farm ponds and small impoundments in eastern South Dakota are productive and often capable of supporting desirable fisheries. The 89,072 farm ponds in South Dakota (Farley, 1970 pers. comm.) currently provide valuable recreation opportunities and may become even more important in the future for both sport fishing and fish farming.

Eutrophication of our natural lakes and increases in human population emphasize our need to understand and conserve pond resources. Fisheries biologists managing these ponds must base their recommendations on knowledge gained by studying a variety of ponds in each geographical area.

Nationwide there has been a large amount of research on many aspects of farm pond fisheries. Men such as Swingle and Smith, Alabama; Bennett and Hansen, Illinois; Barnikol and Campbell, Missouri; and Carlander, Iowa, have devoted much time and effort to gain knowledge of farm ponds. Although this previous research is basic and important to studies of South Dakota farm ponds, the ponds in each area of the country have unique characteristics and problems which can be solved only by studies of those particular ponds. Previous research on South Dakota farm ponds concerned winterkill of fish (Johnson, 1960), limnology (Graham, 1966) and fish populations (Thorn, 1969). The previous studies described the properties of these ponds and provided basic knowledge for further study of these and other similar ponds. Previous research conducted at Labolt Pond was concerned with population dynamics, standing crop and coefficients of condition of the fish (Thorn, 1969).

The present study conducted in a highly productive pond (Thorn, 1969) with fish populations of 12 species of unusual diversity, may reveal pertinent knowledge beneficial to fisheries biologists concerning stocking rates, species combinations and fish harvest. The objectives of the present study were to analyze food habits of the major fish species population and possible interspecific competition concerning food habits.

Labolt Pond supports a healthy and stable fish population. Thorn (1969) reported high coefficients of condition, higher than in many reported studies in spite of the large numbers of fish. It is, therefore reasonable to suggest that either there is sufficient forage present to sustain any combination of fish species and factors other than food limit the population or that interspecific competition concerning food habits does exist among the species present.

DESCRIPTION OF STUDY AREA

Labolt Pond is a small impoundment of the South Fork of the Yellow Bank River located on the Coteau des Praires, Grant County, in northeastern South Dakota. The pond is part of a locally-maintained state recreation area.

The pond has a surface area of 1.9 ha (4.7 a), maximum depth of 3.4 m (11.0 ft) and a mean depth of 1.8 m (5.8 ft). When the dam was completed in 1935, the pond had 4.85 ha of surface area and a maximum depth of 6.1 m (State Water Resources Commission, 1970 pers. comm.). The water level decreases after spring run-off to a low in August thus creating a closed system until fall rains again fill the pond. Land use in the drainage is varied with a mixture of hay, crop and pasture land.

Water temperature in Labolt Pond during the study ranged from 1.0 to 29.0 C; secchi disc visibility, from 40 to 112 cm; total alkalinity concentrations, from 200 to 310 mg/l and dissolved oxygen from 0.0 mg/l at the bottom during stratification to 10.4 mg/l at the surface. Thermal stratification occurred during three brief periods with mixis occurring the week prior to July 22, August 25 and September 14. Limnological characteristics (Appendix A) of Labolt Pond are comparable to those reported for "typical" eastern South Dakota lakes (Schmidt, 1967).

The twelve species of fish present (Table 1) provide an unusual multispecies fish population. The number of one year and older fish

Table 1. Fish commonly found in Labolt Pond[1]

Common name	Scientific name
Northern pike	Esox lucius Linnaeus
Creek chub	Semotilus atromaculatus (Mitchill)
White sucker	Catostomus commersoni (Lacépède)
Black bullhead	Ictalurus melas (Rafinesque)
Yellow bullhead	Ictalurus natalis (Lesuer)
Pumpkinseed	Lepomis gibbosus (Linnaeus)
Orangespotted sunfish	Lepomis humilis (Girard)
Bluegill	Lepomis macrochirus Rafinesque
Largemouth bass	Micropterus salmoides (Lacépède)
White crappie	Pomoxis annularis Rafinesque
Black crappie	Pomoxis nigromaculatus (Lesuer)
Yellow perch	Perca flavescens (Mitchill)

[1]Names of fish according to Trans. Amer. Fish. Soc., Spec. Publ. No. 6, A List of Common and Scientific Names of Fishes from the United States and Canada, 3rd Edition, 1970.

was estimated to be 7347 fish with a total standing crop of 622 kg/ha. Thorn (1969) reported 5016 adult fish and a total standing crop of 550.6 kg/ha. White suckers had the highest standing crop (212 kg/ha) or 34.2 percent of total weight. White crappies, black crappies and yellow perch followed with 152 kg/ha (24.3 percent), 146 kg/ha (23.3 percent) and 38.3 kg/ha (6.2 percent) respectively (Appendix B).

Phytoplankton populations were variable and were composed mainly of green and yellow-brown algae. Diatoms were dominant in June and July with green algae dominant in August and September. No blue-green algae was found in any sample (Table 2).

Table 2. Number of Phytoplankton expressed as cells/liter in Labolt Pond through June 1 to December 3, 1970

	6/1	6/10	6/22	7/1	7/13	7/22
Pyrrhophyta						
Ceratium				992	71	46428
Protozoa						
*Difflugia**	2477	1504	16320		238	
Chlorophyta						
Scenedesmus		65		992	119	
Pediastrum		645	907		9515	
Nephrocytium						
Gloecystis						
Ulothrix					2141	
Ankistrodesmus						
Closteridium			2720	992	119	
Phacotus						
Chrysophyta						
Dinobryon	8095			1792000	1903	
Stephanodiscus	828	262	2720	992		
Gyrosigma	2477	65				
Fragilaria		1177	6347	992		
Synedra		1493	2720		119	
Cymbella		65	907			
Unidentified Pennate Diatoms	9938	1112	9973	992	357	
Euglenophyta						
Euglenales						
Trachalomonas						
Total	23815	6388	42614	1797952	14582	46428

Table 2. (Continued)

	8/3	8/12	8/25	9/2	10/19	12/3
Pyrrhophyta						
Ceratium						
Protozoa						
*Difflugia**				trace		
Chlorophyta						
Scenedesmus			3774			
Pediastrum	6253					
Nephrocytium					1237	
Gloecystis	782		7547	4		
Ulothrix	782		2830	81		
Ankistrodesmus			943			
Closteridium						
Phacotus		19774	191328	trace	4948	3067
Chrysophyta						
Dinobryon	156					
Stephanodiscus					trace	
Gyrosigma		trace			trace	1533
Fragilaria					24742	49067
Synedra				1	trace	
Cymbella						
Unidentified Pennate Diatoms		trace			trace	
Euglenophyta						
Euglenales			943		trace	
Trachalomonas			3774	2		1533
Total	7973	19774	212139	88	40205	55200

* *Difflugia* is not considered Phytoplankton but was included because of its presence in samples.

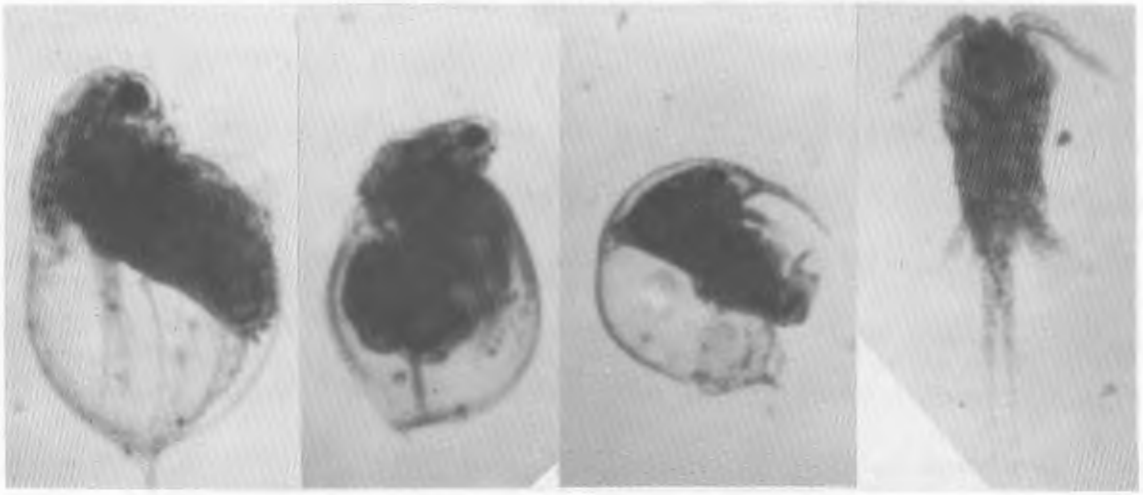
METHODS

Water, phytoplankton, zooplankton, benthos and fish stomach samples were taken on each sampling date. Samples were obtained during June, July and August at 10-day intervals and at two-week intervals in September and October.

Fish were collected with trap nets fitted with either 1.91 or 2.54 cm bar mesh. Nets were left in the water 3 to 5 hours. Captured fish were grouped by species into 5-cm groups and stomach contents from a maximum of 10 fish per species group were taken if available. The 354 fish sampled included 66 black crappies, 177 white crappies, 77 yellow perch and 34 white suckers. Due to the large percentage (97 percent) of the black crappies in year class III and ranging 150 to 199 mm in total length, the majority of black crappies sampled were from this group. Another bias occurred in yellow perch samples as 64 of 77 yellow perch sampled were in age class II, (125 to 174 mm in total length). Most size classes of white crappies and white suckers were sampled.

White suckers and young-of-the-year fish were sacrificed and stomachs removed. Stomach contents from black crappies, white crappies and yellow perch were collected with the aid of a modified Seaburg (1957) stomach pump (Figure 1). At regular intervals fish were sacrificed, stomachs removed and examined to determine if entire contents were being collected. All stomach samples from specific species groups for each sampling date were pooled

Figure 1. Modified Seaburg stomach pump in operation.



a b c d

Figure 2. Major species of zooplankton present in Labolt Pond: a. Daphnia spp.; b. Ceriodaphnia quadrangula; c. Bosmina longirostris; d. Cyclops, June 1 to December 3, 1970.

(Borgeson, 1963) and preserved with 10 percent formalin for later analysis.

The number of microcrustaceans in each sample was determined by counting three one-milliliter subsamples of a fixed volume in a counting wheel (Ward, 1955). Total counts were made of the remaining organisms. The food item contributing the greatest volume to the contents of each stomach was recorded as a dominant food item. This determination involved the visual inspection of food items grouped according to species to determine which group contributed the greatest volume. Since the greatest volume was determined by gross inspection, at times it was not possible to determine which of two approximately equal groups had more volume. In these cases a "first" ranking was given to each (Etnier, 1971).

Three samples with an Ekman dredge (15.2 cm x 15.2 cm) were used to estimate relative abundance of benthic organisms. Bottom materials were washed through a benthos bucket fitted with a 30 mesh per inch screen. Retained material was preserved in 10 percent formalin for laboratory analysis where organisms were separated from detritus using the sugar floatation technique (Anderson, 1959). Total counts of organisms were made and individual groups identified. For the purpose of this study Chironomidae and Ceratopogonidae were considered in one group.

Zooplankton samples were collected with a Miller sampler fitted with a # 10 net. Organisms were counted by the same method as microcrustaceans in stomach samples. Copepods were identified to genus

and Cladocerans to species. Daphnia parvula Fordyce and Daphnia ambigua Scourfield for the purpose of this study, were considered to be one group, and are listed as Daphnia spp.

Phytoplankton samples were collected through a vertical tow with a Wisconsin phytoplankton net. Three one-milliliter subsamples of a fixed volume were counted in a Sedgwick-Rafter counting chamber.

Keys used for the identification of organisms were: Freshwater Biology, (Edmonson, 1966), 2nd Ed. and An Introduction to the Identification of Chironomid Larvae, (Mason, 1968).

An electivity index (E), described by Ivlev (1961), was used to interpret the selective feeding habits of the fish. The index was only used for zooplankton because their life habits make quantification of populations relatively accurate and efficient. The formula,

$$E = \frac{r_i - p_i}{r_i + p_i}$$

has two variables, r_i (percent composition of the food item in the stomach) and p_i (percent composition of the food item in the environment). Values of the electivity index range from -1 (negative selection) through 0 (random selection) to +1 (positive selection).

All percentages used in the discussion of food habits were rounded off to the nearest whole percent.

RESULTS AND DISCUSSION

Aquatic insects, crustaceans and fish were major food items for white suckers, white crappies, black crappies and yellow perch. Utilization of food items was different for each fish species and was apparently influenced by availability of the food item as well as its vulnerability to predation and the preferences of each species of fish. The following discussion first deals with the availability of food items and then discusses specific food habits of the dominant species of fish in Labolt Pond.

Available Food

Zooplankton, aquatic insects, oligochaetes and fish dominated samples of forage material from Labolt Pond. Total zooplankton counts ranged from 29 to 1697 organisms/l. The peak which occurred during the first week in June was dominated by Keratella (Table 3). Total numbers and relative abundance of zooplankton species varied sharply throughout the study. Major zooplankters present and their range in percent of total zooplankton standing crop were: Bosmina longirostris (O. F. Müller) 0 to 672 organisms/l (3 to 99 percent), Daphnia spp. 1 to 138 organisms/l (1 to 24 percent), Ceriodaphnia quadrangula (O. F. Müller) 1 to 186 organisms/l (1 to 48 percent), and Cyclops 1 to 106 organisms/l (1 to 91 percent) (Figure 2). Other zooplankters present were: Diaptomus, copepod naupli, Ostracods and Asplanchna.

Table 3. Zooplankton population expressed as number of organisms per liter (with percent of total in parentheses) in Labolt Pond June 1 through December 3, 1970

	6/1	6/10	6/22	7/1	7/13	7/22	8/3
Cladocera							
Bosmina longirostris	0	7 (12.1)	1 (3.0)	32 (15)	672 (61.4)	401 (99.0)	8 (27.6)
Daphnia spp.	1 (2.2)	7 (12.1)	8 (24.2)	44 (20.6)	138 (12.6)	.7	3 (10.3)
Ceriodaphnia quadrangula	1 (2.2)	16 (27.6)	7 (21.2)	23 (10.2)	111 (10.2)	1.4 (.4)	5 (17.2)
Copepoda							
Calanoida *Diaptomus*	0	1 (1.7)	0	0	6 (0.5)	0	0
Cyclopodia *Cyclops*	12 (26.1)	27 (46.6)	7 (21.2)	89 (41.8)	106 (9.7)	.5 (0.1)	4 (13.8)
Naupli	32 (69.6)	0	10 (30.3)	25 (11.7)	61 (5.6)	0	0
Ostracoda	0	trace	0	0	0	trace	0
Rotifera							
**Keratella*	1651	196	907	0	0	0	0
Asplanchna	0	0	0	0	0	0	9 (31.0)
Total	1697	254	940	213	1094	419	29

*Not figured in percent of total

Table 3. (Continued)

	8/12	8/25	9/2	9/14	10/2	10/19	12/3
Cladocera							
Bosmina longirostris	13 (12.1)	12 (4.7)	116 (27.2)	24 (19.2)	14 (18.9)	11 (12.9)	2 (3.8)
Daphnia spp.	9 (8.4)	12 (4.7)	29 (6.8)	8 (6.4)	10 (13.5)	8 (9.4)	1 (1.9)
Ceriodaphnia quadrangula	47 (43.9)	122 (47.8)	186 (43.6)	33 (26.4)	6 (8.1)	7 (8.2)	1 (1.9)
Copepoda							
Calanoida *Diaptomus*	6 (5.6)	4 (1.6)	3 (0.7)	1 (0.8)	1 (1.4)	.5 (0.6)	1 (1.9)
Cyclopodia *Cyclops*	13 (12.1)	66 (25.9)	83 (19.4)	59 (47.2)	43 (58.1)	59 (69.0)	48 (90.6)
Naupli	0	0	0	0	0	0	0
Ostracoda	0	0	0	0	0	0	0
Rotifera							
**Keratella*	0	0	0	0	0	0	0
Asplanchna	19 (17.8)	39 (15.3)	10 (2.3)	0	0	0	0
Total	107	255	427	125	74	85.5	53

*Not figured in percent of total

Benthos populations ranged from 256 to 4232 organisms/m^2 with chironomids, ceratopogonids and oligochaetes the dominant benthic forms present (Table 4) (Figure 3). There appeared to be a hatch of chironomids between August 5-12 as the numbers of organisms dropped from 269 to 0 organisms/m^2 and then remained low for several weeks. Ceratopogonids were present in relatively the same numbers (328 to 1088 organisms/m^2) throughout the study with the exception of one sample in which only 28 organisms/m^2 were found. Oligochaetes were present in high numbers (3360 organisms/m^2 on June 1) followed by a sharp decrease and then the numbers varied considerably for the remainder of the study with the low of 29 organisms/m^2 occurring October 19.

Other organisms observed either in benthos samples or visual observations of littoral areas were phantom midges (Chaoborus), predacious diving bettles (Dytiscidae), mayflies (Baetidae), corixids (Corixidae), damsel flies (Agrionidae), water mites (Arachnida), leeches (Hirudinea), water scorpions (Nepidae) and fish. Life habits, habitat differences, seasonal movements and migration or spatial distribution made accurate quantification of these organisms difficult and limited. Seining revealed large numbers of water scorpions, young-of-the-year fish and small numbers of creekchubs. Young-of-the-year fish consisted of black crappies, white crappies, bluegills, largemouth bass in relatively abundant amounts and very few black bullheads and white suckers.

Table 4. Benthos standing crop expressed as number of organisms per square meter in Labolt Pond June 1 through October 19, 1970

	6/1	6/10	6/22	7/1	7/13	7/22
Arthropoda						
Insecta						
Diptera						
Chironomidae (total)	643	271	1116	586	143	105
Procladius sp.	143	57			29	
Cryptocladolema amacherus	143	114	43		14	29
Chironomus plumosus	57		372	586	14	
Tanypus sp.		57	701		86	76
Cryptochironomus sp.		29				
Polypedilum sp.		14				
Ceratopogonidae	529	830	758	328	830	1088
Culicidae *Chaoborus*				14		
Coleoptera Dytiscidae		43	14			
Ephemeroptera Baetidae		43				
Hemiptera Corixidae						14
Odonata Agrionidae			14			
Arachnida					29	
Annelida						
Hirudinea		57			14	
Oligochaeta	3360	1889	228	43	143	774
Total	4232	3133	2130	971	1159	1981

Table 4. (Continued)

	8/3	8/12	8/25	9/2	9/14	10/19
Arthropoda						
Insecta						
Diptera						
Chironomidae (total)	269	0	29	14	28	172
Procladius sp.	14				14	29
Cryptocladolema amacherus						
Chironomus plumosus	29			14	14	86
Tanypus sp.	212		29			
Cryptochironomus sp.	14					57
Polypedilum sp.						
Ceratopogonidae	544	28	715	974	800	329
Culicidae						
Chaoborus	28		29			
Coleoptera						
Dytiscidae						
Ephemeroptera						
Baetidae						
Hemiptera						
Corixidae						
Odonata						
Agrionidae						
Arachnida						
Annelida						
Hirudinea						
Oligochaeta	715	228	43	57	490	29
Total	1556	256	816	1045	1318	530

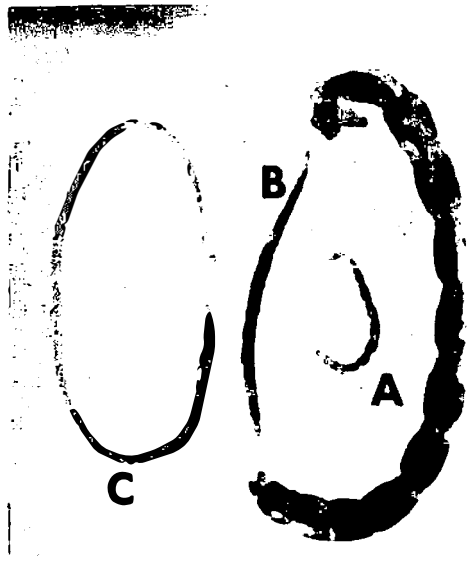


Figure 3. Dominant benthic organisms present in Labolt Pond: a. Chironomidae; b. Ceratopogonidae; c. Oligochaeta, June 1 to December 3, 1970.

It appeared that the fish were utilizing almost all types of available food as nearly every forage group present was represented in stomach samples.

Food Habits

Black Crappies Zooplankton and aquatic insects were the most abundant food items present in black crappie stomachs. Cladocerans and copepods, occurring in all size class samples, were the most numerous food item and constituted a major portion of the total volume of food in 70 percent of the samples. Daphnia spp., the most important zooplankter, comprised 56 percent to 96 percent of the total number while other zooplankters; Cyclops (3 percent to 33 percent), C. quadrangula (0 percent to 13 percent) and B. longirostris (1 percent to 78 percent) were of less importance (Table 5).

Black crappies, from all size classes, positively selected Daphnia spp. with the electivity index ranging from +.309 to +.873. Adult fish negatively selected B. longirostris (-.342 to -.897), C. quadrangula (-.366 to -1.0) and Cyclops (-.031 to -.895) with the exception of one sample when Cyclops was positively selected (+.410). Young-of-the-year black crappies positively selected Cyclops (+.366) and Daphnia spp. (+.309) and negatively selected B. longirostris (-.743) while appearing to randomly select C. quandrangula (+.077).

Other crustaceans, ostracods and malacostracans were consumed in small amounts and were the dominant food item present in only one sample (Table 6).

Table 5. Percent composition of zooplankton in the environment and in the stomach and the Electivity Index for black crappies in Labolt Pond June 10 through October 19, 1970

Date	Age Class		*Cyclops* sp.	*Ceriodaphnia quadrangula*	*Daphnia* spp.	Bosmina *longirostris*
6/10		p_i	46.5	27.6	12.1	12.1
	IV	r_i	6.4	12.8	76.6	3.2
		E^i	-.758	-.366	+.727	-.581
8/3		p_i	13.8	17.2	10.3	27.6
	III	r_i	33.0	8.5	56.4	2.1
		E^i	+.410	-.338	+.691	-.858
8/25		p_i	25.9	47.8	4.7	4.7
	III	r_i	24.3	2.9	69.9	2.9
		E^i	-.031	-.885	+.873	-.342
9/2		p_i	19.4	43.6	6.8	27.2
	0	r_i	32.2	50.9	12.9	4.0
		E^i	+.366	+.077	+.309	-.743
	III	r_i	2.7	5.2	86.0	6.0
		E^i	-.755	-.786	+.853	-.638
9/14		p_i	47.2	26.4	6.4	19.2
	III	r_i	7.6	6.4	81.9	4.0
		E^i	-.722	-.609	+.855	-.655
10/2		p_i	58.1	8.1	13.5	18.9
	III	r_i	7.3	2.8	82.0	7.8
		E^i	-.776	-.486	+.717	-.415
10/19		p_i	69.0	8.2	9.4	12.9
	IV	r_i	3.8	0.0	95.5	0.7
		E^i	-.895	-1.00	+.820	-.897

p_i percent composition of zooplankton in the environment

r_i percent composition of zooplankton in the stomach

E Electivity Index

Table 6. Total number of food items consumed by black crappies in Labolt Pond June 10 through October 2, 1970

Date:	6/10	7/13	8/3	8/12	8/25	9/2		9/14	10/2	10/2
Age Class	IV	IV	III	III	III	yoy	III	III	III	IV
Number of fish per sample	2	2	10	10	10	3	8	10	6	5
Cladocera		#								
Ceriodaphnia quadrangula	220		520	190	144	2514*	430	1155	317	
Daphnia spp.	1320*		3445	48830*	3456	636	7100*	14685*	9341*	405
Bosmina longirostris	55		130	190	144	198	500	710	893	3
Cyclops sp.	110		2015	3030	1200	1588	230	1370	835	16
Ostracoda	18		20							
Malacostraca										
Gammarus sp.					1				2	38*
Insecta										
Odonata			4				1			
Corixidae	2	1*			2				9*	1
Chironomidae-Ceratopogonidae	10	3*	455*	76	96		14*	82		
Fish	1		1		4*					

- Cladocerans present but too digested to count or identify.

yoy - Young-of-the-year fish

* - Major food item

Aquatic insects (present in all samples of adult fish) and small fish were nearly as important as crustaceans on a volume basis. Aquatic insects were not found in any sample taken from young-of-the-year black crappies. Dipterans (70 percent occurrence) from the families Chironomidae and Ceratopogonidae were the dominant food item in 30 percent of the samples. Corixids and Odonata naiads occurred in 40 percent and 20 percent of the samples respectively and corixids were the dominant food item in 10 percent of the samples. Fish occurred in 30 percent of the samples and were the dominant food item in 10 percent of the samples.

The following discussion of previous research shows the food habits of black crappies in Labolt Pond are both similar and dissimilar to food habits of black crappies in other studies.

McConnell (1963) examined the stomach contents of 32 black crappies 71 to 147 mm in total length and found that cladocerans occurred in 62 percent of the samples and constituted 40 percent of the total volume. In larger fish (135 to 198 mm total length) cladocerans were found in 84 percent of the samples and comprised 70 percent of the total volume. Cladocerans, the most important zooplankter present in 130 black crappie stomachs examined by Pearse (1919), comprised 33 percent of the total volume while copepods and ostracods were insignificant.

Planktonic crustaceans and small bodied diptera larvae were the most important food items for black crappies 60 to 119 mm in total length. Larger fish, 160 to 240 mm, fed on insects or fish although cladocerans and copepods were taken by black crappies three years old and 160 mm in total length (Keast, 1968).

Black crappies, less than 100 mm in total length, fed almost entirely on entomostracans while 12 percent of adults (greater than 100 mm total length) took them for food. Copepods (Cyclops and Diaptomus) constituted 84 percent of the total number. Insects were the most frequently taken food item as they occurred in 80 percent of the stomachs with chironomids and Chaoborus constituting 52 percent of the insects consumed (Reid, 1949).

Kutkuhn (1955) concluded that black crappies were piscivorous in nature as fish occurred in 73 percent of the stomachs and comprised 78 percent of the total volume. Tendiped larvae, the most abundant insect in stomach samples, occurred in 58 percent of the stomachs and comprised 7 percent of the total volume while cladocerans occurred in 37 percent and constituted 6 percent of the total volume.

White Crappies. Zooplankton, aquatic insects and fish were the most important food item of white crappies. Aquatic insects, the most important food item, occurred in 82 percent of the samples and comprised a major portion of the total food volume in 54 percent of the samples (Table 7). Corixids occurred in 57 percent of the samples and constituted a major portion of the total volume in 32 percent of the samples. Other commonly eaten insects were dipteran larvae (Chironomidae and Ceratopogonidae) and damsel fly naiads (Odonata) which occurred in 64 percent and 29 percent of the samples respectively. Mayflies (Baetidae), caddisfly larvae (Trichoptera and predacious living beetles (Dytiscidae) were found in the samples but were never important food items.

Table 7. Total number of food items consumed by white crappies in Labolt Pond June 1 through October 19, 1970

Date:	6/1		6/22			7/1		7/13			7/22			
Age Class:	II	III	II	III	V	II	III	I	II	V	I	II	III	V
Number of fish per sample:	10	6	10	8	1	10	5	2	10	1	10	10	10	1
Cladocera										#				
Ceriodaphnia quadrangula	17400*	114	2392*	3480		130	1590*	624			366	100		
Daphnia spp.	3600	190	1380*	900		967	2610*	4212*	3600		7399	7100	616	
Bosmina longirostris	1800	8	92	60			12	312	300		262	167	54	
Copepoda														
Cyclops sp.	1800	76	92	120				78			933	1530	54	
Ostracoda						33					41	33		
Malacostraca														
Gammarus sp.					15									
Insecta											1	1	20	
Odonata														
Corixidae		4		58*	23*	33*	1		14*		2		56	
Chironomidae-Ceratopogonidae		337*	24*	30	29*	33	1	3	22*		23*		394	2
Baetidae		9											4	1
Trichoptera			2											
Dytiscidae				1	1									
Fish								1	1	1*	4*	9*	20*	8*
Molluska														

Table 7. (Continued)

Date:	8/3		8/12			8/25		9/2			9/14	10/2		10/19
Age Class:	I	II	I	II	V	I	V	yoy	III	V	III	II	III	III
Number of fish per sample:	7	10	6	7	1	5	8	3	8	1	7	2	10	10
Cladocera		#			#									
Ceriodaphnia quadrangula	504		40			1760		1424*	20		180	33	70	
Daphnia spp.	2436*		2376*	5343		16720*	1638	345	1518*		1980	3830*	1979	2600
Bosmina longirostris						440		50	20			133		50
Copepoda														
Cyclops sp.	1190		172	274		220	27	182	80		180	500	210	100
Ostracoda														
Malacostraca *Gammarus* sp.											4*			14*
Insecta														
Odonata		6*					3			1*	4*		1	
Corixidae		3*		4		1	162*				1	6*	23*	47*
Chironomidae-Ceratopogonidae		27*	66	8			54		15*	3	164*			
Baetidae														
Trichoptera														
Dytiscidae														
Fish				4*			2		1				1	
Molluska		1												

* - Major food item
\# - Cladocerans present but too digested to count or identify
yoy - Young-of-the-year fish

Fish occurred in 39 percent of the samples and were a major food item by volume in 21 percent. Consumption of fish appeared to be seasonal as the majority of samples containing fish were collected during July and August. Fish were too digested for positive identification but appeared to be young Centrarchids all less than 25 mm total length.

Zooplankton was found in all samples taken from white crappies, less than 250 mm in total length, and ranked first as most important food item by volume in 36 percent of the samples. Young-of-the-year white crappies consumed only zooplankton with Daphnia spp. the dominant species. Zooplankton occurred in 17 percent of the samples from fish over 250 mm in total length and was not considered a major food item of those fish. Of the samples containing zooplankton, Daphnia spp. was the dominant species in 82 percent while C. quadrangula was the dominant species in the remaining 18 percent of the samples. Bosmina longirostris occurred in 68 percent of the samples and never comprised more than 8 percent of the total number of zooplankton present. Cyclops the only copepod found in stomach samples, occurred in 86 percent but never constituted more than 29 percent of the total number.

White crappies, in all samples with the exception of one, showed a positive selection for Daphnia spp. with the electivity index ranging from -.102 to +.997 (Table 8). Concentrations of Daphnia spp. never accounted for more than 24 percent of the total zooplankton population but constituted 14 percent to 98 percent of the zooplankton food items.

Table 8. Percent composition of zooplankton in the environment and in the stomach and the Electivity Index for white crappies in Labolt Pond June 10 through October 19, 1970

Date	Age Class		Cyclops sp.	Ceriodaphnia quadrangula	Daphnia sp.	Bosmina longirostris
6/10		p_i	46.6	27.6	12.1	12.1
	II	r_i	7.3	70.7	14.6	7.3
		E_i	-.729	+.438	+.093	-.247
	III	r_i	19.5	29.4	49.0	2.1
		E_i	-.409	+.031	+.603	-.704
6/22		p_i	21.2	21.2	24.2	3.0
	II	r_i	2.3	60.5	34.9	2.3
		E_i	-.804	+.481	+.181	-.132
	III	r_i	2.6	76.3	19.7	1.3
		E_i	-.781	+.565	-.102	-.395
7/1		p_i	41.8	10.8	20.6	15.0
	II	r_i	0.0	11.8	88.2	0.0
		E_i	-1.00	+.044	+.621	-1.00
	III	r_i	0.0	37.7	62.0	0.3
		E_i	-1.00	+.554	+.497	-.960
7/13		p_i	9.7	10.2	12.6	61.4
	II	r_i	1.5	11.9	80.6	6.0
		E_i	-.732	+.077	+.729	-.822
	II	r_i	0.0	0.0	92.3	7.7
		E_i	-1.00	-1.00	+.761	-.777
7/22		p_i	0.12	0.42	0.17	99.0
	I	r_i	10.4	4.1	82.0	2.9
		E_i	+.974	+.814	+.995	-.940
	II	r_i	17.1	1.1	79.1	1.9
		E_i	+.973	+.382	+.994	-.964
	III	r_i	7.5	0.0	85.0	7.5
		E_i	+.969	-1.00	+.997	-.859
8/3		p_i	13.8	17.2	10.3	27.6
	I	r_i	28.8	12.2	59.0	0.0
		E_i	+.352	-.170	+.702	-1.00

Table 8. (Continued)

Date	Age Class		Cyclops sp.	Ceriodaphnia quadrangula	Daphnia sp.	Bosmina longirostris
8/12		p_i	12.1	43.9	8.4	12.1
	I	r_i	6.6	1.5	92.0	0.0
		E^i	-.292	-.933	+.832	-1.00
	III	r_i	4.9	0.0	95.1	0.0
		E^i	-.423	-1.00	+.837	-1.00
8/25		p_i	25.9	47.8	4.7	4.7
	I	r_i	1.2	9.2	87.5	2.3
		E^i	-.911	-.677	+.898	-.342
	III	r_i	1.6	0.0	98.4	0.0
		E^i	-.833	-1.00	+.908	-1.00
9/2		p_i	19.4	43.6	6.8	27.2
	yoy	r_i	9.1	71.2	17.2	2.5
		E^i	-.361	+.263	+.433	-.831
	III	r_i	4.9	1.2	92.7	1.2
		E^i	-.596	-.611	+.863	-.915
9/14		p_i	47.2	26.4	6.4	19.2
	III	r_i	7.7	7.7	84.6	0.0
		E^i	-.719	-.548	+.789	-1.00
10/2		p_i	58.1	8.1	13.5	18.9
	II	r_i	11.1	0.9	85.2	2.9
		E^i	-.679	-.800	+.726	-.761
	III	r_i	9.3	3.1	87.6	0.0
		E^i	-.724	-.446	+.814	-1.00
10/19		p_i	69.0	8.2	9.4	12.9
	III	r_i	3.6	0.0	94.5	1.8
		E^i	-.900	-1.00	+.814	-.755

p_i percent composition of zooplankton in the environment

r_i percent composition of zooplankton in the stomach

E Electivity Index

In 55 percent of the samples containing zooplankton, C. quadrangula was negatively selected (-.170 to -1.00) and in the remaining 45 percent of the samples positively selected (+.031 to +.814) with positive selection occurring during June and July while negative selection occurred during August, September and October. Cyclops was negatively selected in 82 percent of the samples with positive selection occurring when B. longirostris dominated the zooplankton population. White crappies strongly selected against B. longirostris in all samples as the electivity index ranged from -.132 to -1.00.

Other crustaceans (ostracods and malacostracans) were present in very small numbers and ranked first in importance only when Gammarus was a major food item on October 14.

Food items and their percent of total volume of white crappies taken from Lake Wingra, Wisconsin, were: insects (39 percent), particularly immature stages; cladocerans (21 percent); copepods (19 percent); amphipods (7 percent) and fish (6 percent) (Pearse, 1919).

March (1954) concluded that cladocerans and copepods are the most important food item of young crappies. Siefert (1969) reported that young crappies (4.8 to 15.5 mm total length) in Lewis and Clark Lake relied on cladocerans for their major source of food.

Ewers and Boesel (1935) examined the stomach contents of 137 white crappies in the 15 to 60 mm size range. The specimens were found to contain 91 percent crustaceans, 4 percent insects and 5 percent detritus. In general cladocerans were present in greater abundance than were copepods.

Stevens (1959) reported insects occurring in 77 percent of the stomachs but never comprising more than 5 percent of the stomach contents. Fish occurred in 56 percent of the stomachs and constituted at least one-half of the total food volume in 22 percent of the stomachs.

Fish, a major food item in a study conducted by Neal (1963), were found to make up 50 percent or more of the total volume of food in 49 percent of the stomachs. Goodson (1965) reported that threadfin shad dominated the diet of white crappies (greater than six inches in length) in California reservoirs.

Yellow Perch Fish, crayfish and aquatic insects were the most important food items of perch. Fish and crayfish each occurred in 50 percent of the samples and were the dominant food item in 25 and 33 percent respectively (Table 9). Aquatic insects occurred in all samples and were the most important food item in 33 percent. Dipteran larvae (Chironomidae-Ceratopogonidae) and corixids (both adult and immature) each were the dominant food item in 25 percent of the samples. Trichopterans were the dominant food item in 18 percent of the samples. Other insects, damsel flies (Odonata) and mayflies (Ephemeroptera), were present but were never a dominant food item. Cladocerans, the major food item in 10 percent of the samples, occurred in 25 percent. Other food items (water mites, clams and snails) occurred in some samples but were never important food items.

Table 9. Total number of food items consumed by yellow perch in Labolt Pond July 1 through October 19, 1970

Date:	7/1	7/13	7/22	8/3	8/12	8/25	9/2		9/14	10/2	10/19	
Age Class:	II	II	II	II	II	II	II	IV	II	II	II	V
Number of fish per sample:	4	6	4	5	10	8	10	10	10	2	5	3
Cladocora		#		#				#	#*	#		
Daphnia spp.	30				91							
Copepoda												
Cyclops sp.	2				3							
Insecta												
Odonata	1		2						1		1	3
Corixidae	16	1		4*							137*	74*
Chironomidae-Ceratopogonidae	44	57*	3	11*	254*	30	22	2	26		2	
Baetidae	1		1									
Trichoptera			1						6	6*		
Arachnida				6	2	1						
Docopoda	1*		1*		1*			1*			1	1
Fish			1	1*		2*	1*	1			1	
Mollusca												
Gastropoda				1		1						
Pelecopoda					1	1						
Sago pond weed					@		@					@

- Cladocerans present but too digested to count and identify.
* - Major food item
@ - Sago pond weed present in sample

Unlike perch from Labolt Pond, perch (45 to 162 mm total length) in Buckeye Lake, Ohio, depended upon crustaceans for the major portion of their food as cladocerans, copepods and amphipods made up 60 percent of the total volume while insects comprised 32 percent of the volume (Ewers and Boesel, 1935).

Kutkuhn (1955) reported that zooplankton was not an important food item as it occurred in 17 percent of the samples and only constituted <1 percent of the total volume. Insects occurred in 31 percent of the stomachs of adult perch and comprised 2 percent of the total volume while the most important food item, fish, accounted for 96 percent of the volume and occurred in 89 percent of the samples.

White Suckers. Twenty-four out of 34 white suckers (100 to 574 mm total length) contained food, only the fish containing food items were considered in the following discussion. Microcrustaceans (Cladocera and Copepoda), the dominant food item, occurred in 88 percent of the stomachs and accounted for the greatest volume of food in 75 percent of the stomachs (Table 10). Ostracods were the most abundant food item in only one stomach. Detritus, which appeared to be bottom material composed of organic material and broken mollusk shells, comprised the greatest percent of volume of food in 21 percent of the stomachs.

Ceriodaphnia quadrangula was the most abundant cladoceran in 42 percent of the stomachs. Suckers of all sizes fed on zooplankton and were selective during feeding. Suckers that fed on C. quadrangula

Table 10. Total number of food items consumed by white suckers in Labolt Pond June 22 through October 19, 1970

Date:	6/22		7/22		8/3	8/12	8/25			9/2			9/14			10/19
Age Class:	II	IV	IV	V	I	IV	II	III	IV	yoy	II	III	II	III	V	V
Number of fish per sample:	1	1	4	1	2	1	2	2	1	1	1	1	1	2	1	2
Cladocera	#*		#*	#*											#*	
Coriodaphnia quadrangula		3255*			1368*		3149*	3937*			4224*	4465	3189	9483*		
Daphnia spp.		3255*			76	115	536	627		18	221	1175	379	2330		
Bosmina longirostris					228		201	643			3360*		6400*	9553*		
Cyclops sp.					11	45		372		18			513	1444		
Ostracoda										1988*	125					
Insecta																
Odonata											1					
Chironomidae-Ceratopogonidae @*						35*								494		
Mollusca																
Pelecypoda						5						1	1			*
Detritus						pr*			pr*			pr*				pr*

* - Major food item

\# - Cladocerans present but too digested to count or identify

@ - Chironomidae-Ceratopogonidae present but too digested to count

pr - Present

positively selected it as indicated by the range of the electivity index (+.070 to +.650) (Table 11). Daphnia spp. occurred in 58 percent of the stomachs and was positively selected in 38 percent of the stomachs.

White suckers were the only fish studied from Labolt Pond that positively selected B. longirostris. Bosmina longirostris occurred in 42 percent of the stomachs and was positively selected in 38 percent of the stomachs. Cyclops occurred in 38 percent of the stomachs, was positively selected in 8 percent and never was a major food item.

Aquatic insects, Chironomidae-Ceratopogonidae and Odonata, occurred in 21 percent of the stomachs and were major food items only in one stomach. Clams, the only non-Arthropod food item were found in 12 percent of the stomachs.

Olson (1963) reported that from the size class, 96.5 to 248.9 mm, 90 percent of the stomachs contained microcrustaceans, 14 percent contained chironomids and all but one of 62 had taken aquatic insects. Suckers from Labolt Pond depended on microcrustaceans also but did not take insects as often. In a similar study, Olson (1963) found that large suckers (316 to 523 mm) did not take microcrustaceans as often as they were present in only 18 percent of the stomachs while food items occurring more often were: midge larvae, 92 percent; caddisflies, 72 percent; mayflies, 62 percent and mollusks, 18 percent. In one study it was reported that algae was the most important food comprising 75 percent to 95 percent of

Table 11. Percent composition of zooplankton in the environment and in the stomach and the Electivity Index for white suckers in Labolt Pond June 10 through October 19, 1970

Date	Age Class		*Cyclops* sp.	*Ceriodaphnia quadrangula*	*Daphnia* spp.	*Bosmina longirostris*
6/22		p_i	21.2	21.1	24.2	3.0
	IV	r_i	0.0	50.0	50.0	0.0
		E^i	-1.00	+.406	+.347	-1.00
8/3		p_i	13.8	17.2	10.3	27.6
	I	r_i	0.6	81.3	4.5	13.5
		E^i	-.916	+.650	-.391	-.343
8/12		p_i	12.1	43.9	8.4	12.1
	IV	r_i	28.1	0.0	71.9	0.0
		E^i	+.398	-1.00	+.791	-1.00
8/25		p_i	25.9	47.8	4.7	4.7
	II	r_i	0.0	81.0	13.8	5.2
		E^i	-1.00	+.257	+.319	+.050
	III	r_i	6.7	70.6	11.2	11.5
		E^i	-.588	+.192	+.408	+.419
9/2		p_i	19.4	43.5	6.8	27.2
	0	r_i*	0.8	0.0	0.8	0.0
		E^i	-.920	-1.00	-.789	-1.00
	II	r_i	0.0	53.3	2.8	42.4
		E^i	-1.00	+.101	-.416	+.218
	III	r_i	0.0	51.5	13.9	32.3
		E^i	-1.00	+.086	+.342	+.085
9/14		p_i	47.2	26.4	6.4	19.2
	II	r_i	4.9	30.4	3.6	61.1
		E^i	-.811	+.070	-.280	+.521
	III	r_i	6.3	41.6	10.2	41.9
		E^i	-.764	+.223	+.228	+.371

p_i percent composition of zooplankton in the environment

r_i percent composition of zooplankton in the stomach

E Electivity Index

* Ostracods constituted 98.2 percent of the zooplankton in the stomach

the food taken (Nurnberger, 1928). Unlike white suckers in Labolt Pond, Olson (1963) showed as suckers grew older, consumption of microcrustaceans decreased from 89 percent to 5 percent of the total volume and consumption of insects increased from 11 percent to 73 percent of the total volume.

In addition to young-of-the-year fish, food habits previously discussed, stomachs from largemouth bass, bluegills and black bullhead young were examined. In all stomachs, as in young white crappies and black crappies, zooplankton was the most important and most abundant food item. Young largemouth bass were the only young-of-the-year fish to take food items other than zooplankton as occasionally aquatic insects were taken by the young bass.

Food habits of black crappies and white crappies were very similar; the only major difference was in the utilization of zooplankton. Zooplankton was a major food item in 70 percent of black crappies but only in 36 percent of white crappies. White crappies greater than 250 mm total length did not take zooplankton as often as smaller crappies did.

Yellow perch and white suckers food habits were not at all similar; the latter depended on zooplankton for the major food source, the former depended on fish, crayfish and insects. A combination of the food habits of perch and suckers would be very similar to the food habits of black and white crappies.

Young-of-the-year fish and white suckers exhibited very similar food habits, as both groups depended upon zooplankton as their major food source.

SUMMARY AND CONCLUSIONS

Crustaceans, aquatic insects and fish were the most important food item found in stomach samples from black crappies, white crappies, yellow perch and white suckers taken from Labolt Pond.

Black crappies depended on zooplankton and aquatic insects as their major food source as they occurred in all samples and were major food items in 70 percent and 40 percent of the samples respectively. Black crappies strongly selected Daphnia spp. and negatively selected B. longirostris.

Insects, zooplankton and fish were the major food items of white crappies. Insects, the major food item, were the dominant forage present in 54 percent of the samples while zooplankton and fish were dominant in 36 percent and 21 percent of the samples respectively. Daphnia spp. was positively selected and B. longirostris negatively selected in all samples.

Perch relied on crayfish, fish and aquatic insects as their major food source. Aquatic insects and crayfish each were the dominant food item in 33 percent of the samples while fish were the major food item in 25 percent.

Microcrustaceans, the most important food item of white suckers, were the major food items present in 75 percent of the sucker stomachs. No distinct pattern in the selection of cladocerans was noted but suckers did positively select B. longirostris, the only species in this study to do so. The copepod, Cyclops, was negatively selected in all samples.

Zooplankton in Labolt Pond appeared to be highly exploited due to the lack of large Cladocerans and Copepods and the dominance of small zooplankters such as Bosmina longirostris, Ceriodaphnia quadrangula, Daphnia parvula, Daphnia ambigua, and Cyclops. Brooks (1969) discussed similar situations where intense predation by fish eliminated the large zooplankters and allowed the small forms to dominate.

Black crappies and white crappies apparently competed for food although black crappies depended upon zooplankton far more than did white crappies. Other food items were taken in relatively the same ratio by both species. Food items of crappies appeared to belong to three or four diverse groups and dependence on one specific item did not exist.

Suckers depended almost entirely on zooplankton as their major source of food. It appeared that suckers could compete with crappies and young-of-the-year fish as they all depended on zooplankton partially or totally as a source of food. Although zooplankton is the major food source for suckers, black crappies and young-of-the-year fish, white suckers appeared to be more random in the selection of zooplankters than black crappies which are strongly selective for Daphnia spp. Interspecific competition would be more realistic between white suckers and young-of-the-year fish because both groups depended on C. quadrangula for a portion of their food. White suckers in Labolt Pond represent 34 percent of the total weight of fish and contribute very little to sport fishing. Due to this fact and that white suckers apparently competed with other fish for zooplankton,

white suckers are an undesirable fish species in Labolt Pond.

Yellow perch, black crappies and white crappies utilized similar food sources and on this basis apparently competed for food. The combination of the three species may be more competitive, than the combination of any two, as all three species depended on aquatic insects and fish for an important portion of their diet. All three species, to a degree, are piscivorous in nature. Therefore, the possibility of predation on young-of-the-year fish exists and interspecific competition (predation) is an important protection against overpopulation. Black crappies, white crappies and yellow perch apparently are able to compete among each other and still maintain a healthy population. Their desirability as sport fish and the competitive nature of their food habits make these three species of fish important to the total fish population of Labolt Pond.

A suggestion for the possible future management of Labolt Pond would be to remove the white suckers and introduce a small forage fish that would be suitable as forage for crappies, perch and largemouth bass, a species not considered in this study but present in the pond.

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Appendix A. Limnological data for Labolt Pond June 1 through December 3, 1970 (chemical analyses as mg/l)

		6/1	6/10	6/22	7/1	7/13	7/22	8/3	8/12	8/25	9/2	9/14	10/2	10/19	12/3
Temperature (C)	S	17.0	24.0	25.0	29.0	28.0	24.5	26.5	29.0	25.5	24.0	13.0	14.0	8.5	1.0
	M	16.5	19.0	18.0	27.0	27.5	25.0	23.5	25.0	23.0	23.5	13.0	14.0	9.0	1.0
	B	14.0	17.0	15.0	24.0	25.0	24.0	21.8	24.0	22.0	22.0	13.0	14.0	8.5	2.0
pH	S	7.3	8.2	7.7	8.2	8.3	8.3	8.2	8.6	8.5	8.7	---	8.5	8.4	8.0
	M			7.5	8.1	8.0	8.3	8.1	8.2	8.5	8.6	---	8.4	8.4	7.6
	B			7.5	7.7	7.8	8.3	8.1	7.7	8.4	8.2	---	8.5	8.4	7.4
Dissolved Oxygen	S	4.4	7.6	8.3	7.0	5.2	6.4	5.4	8.3	6.4	6.2	7.6	7.6	9.0	10.4
	M			8.1	4.4	2.1	4.8	3.6	6.2	6.0	9.1	7.2	7.6	9.0	9.1
	B			1.9	0.8	0.0	4.2	4.0	0.0	5.8	1.4	7.2	7.4	9.0	8.6
Phenol-phthalein Alkalinity	S			0.0	0.0	11.7	0.0	7.2	10.8	5.4	10.8	5.4	12.6	10.8	0.0
	M			0.0	0.0	11.7	0.0	0.0	0.0	10.8	9.0	1.8	8.0	10.8	0.0
	B			0.0	0.0	0.0	0.0	0.0	0.0	5.4	0.0	5.4	11.6	9.0	0.0
Total Alkalinity	S			310	262	252	244	234	220	240	220	227	210	200	306
	M			294	290	261	244	234	234	234	224	227	210	209	306
	B			344	282	270	234	236	246	240	224	223	212	208	318
Calcium Hardness	S	318	348	300	316	250	252	256	198	246	200	220	160	146	320
	M			294	396	244	274	232	198	270	230	188	180	148	350
	B			308	342	244	270	210	220	236	206	228	120	170	378
Total Hardness	S	431	298	420	420	402	406	374	286	292	272	256	308	298	430
	M			408	414	406	402	390	290	292	266	252	298	298	466
	B			430	422	414	400	386	300	298	280	232	270	302	512
Chloride	S	1.55	1.02	1.02	1.55	2.55	1.00	4.59	2.55	2.00	10.0	3.0	4.5	3.0	7.6
	M			1.02	1.02	2.04	1.50	5.10	2.55	2.50	7.5	3.0	3.5	3.0	6.6
	B			1.02	0.52	2.04	1.50	5.10	2.04	1.00	8.5	2.0	4.0	3.0	7.1

Appendix A. (Continued)

	*	6/1	6/10	6/22	7/1	7/13	7/22	8/3	8/12	8/25	9/2	9/14	10/2	10/19	12/3
Sulfate	S	310	240	200	220	225	205	285	200	200	200	210	250	245	360
	M			220	220	225	205	200	180	200	200	205	250	245	350
	B			190	215	225	210	200	200	200	150	225	250	245	360
Sodium	S	8.5	6.9	5.0	9.0	8.5	4.5	4.0	8.6	8.9	8.7	5.2	2.0	4.5	4.5
	M			6.2	8.0	6.5	4.5	4.4	8.2	8.3	8.6	4.5	5.0	4.5	7.0
	B			6.5	8.0	6.5	4.5	4.0	8.4	9.0	8.2	5.3	4.0	4.5	7.0
Potassium	S	5.4	5.3	6.4	4.8	5.6	5.7	9.7	5.5	6.0	6.6	7.5	4.8	7.5	8.5
	M			6.4	4.8	5.8	5.9	6.4	5.4	6.0	6.8	7.1	8.1	7.1	8.5
	B			6.6	4.8	6.0	5.7	6.0	5.8	6.1	8.1	6.8	10.2	7.3	8.2
Total Phosphorus	S	2.3	3.0	1.5	0.9	1.2	1.1	3.0	0.19		0.175				
	M				0.9	1.1	1.2	1.8	0.25	0.17	0.135	0.135	0.26	0.24	0.065
	B			2.7	2.1	1.4	1.8	2.0	0.62		0.265				
Specific Conductance Micromhos/ cm	S	900	845	790	780	775	735	750	710	730	700	640	410	750	1050
	M			800	780	750	760	740	710	725	698	600	600	710	1100
	B			800	790	780	755	730	740	695	700	650	600	710	1240
Secchi disc Visibility (cm)	S	40	70	90	112	95	55	63	90	60	100	45	60	75	
Total Organic Weight	S	16.80	15.68	23.52	24.64	22.40		21.57	24.71	32.22	27.46	32.93	30.81	33.19	28.49
	M			20.44	25.76	20.16		29.39	18.50	21.00	24.36	28.69		31.51	25.63
	B			19.88	22.40	21.28	10.36	19.85	26.24	26.60	25.20	33.69	47.98	31.51	18.11
Dissolved Organic Weight	S	19.60	17.92	23.52	14.00	5.47	12.38	15.92	24.71	24.93	21.84	4.47	15.57	27.29	21.17
	M			10.36	21.56	10.65	17.27	18.39	18.50	17.08	18.48	32.22		15.05	21.64
	B			15.68	11.20	10.94	19.00	18.10	26.24	22.40	19.04	24.93	45.86	28.69	17.88

*Sampling depths, S - surface; M - middle; B - bottom.

Appendix B. Estimated numbers and standing crops of fish in Labolt Pond, 1970

Species	Age Class	Size (mm)	Average Weight (g)	Total Number	Total Weight (kg)	Percent Total Number	Percent of Total Weight
Pumpkin-seed	I	100-124	30	181	7.1		
	II	125-149	90	232	20.9		
	III	150-199	125	138	17.2		
	Total			551	45.2	7.5	3.8
White Crappie	I	100-149	25	1102	27.6		
	II	150-199	61	559	34.0		
	III	200-224	193	1067	205.9		
	IV	225-249	219	42	6.8		
	V	250-274	350	38	13.3		
	Total			2808	287.6	38.4	24.3
Black Crappie	II	125-149	62*	24	1.5		
	III	150-199	131	2052	268.8		
	IV	200-249	163*	44	7.2		
	V	250-274	300	1	0.3		
	Total			2121	277.8	28.9	23.3
Yellow Perch	II	125-174	77	510	39.3		
	III	175-199	83	307	25.5		
	IV	200-249	132	60	7.9		
	Total			877	72.7	12.0	6.2
Bluegill	I	100-149	34	26	0.9		
	II	150-174	112	45	5.0		
	Total			71	5.9	1.0	0.5
Largemouth Bass	I	100-149	58*	5	0.3		
	II	150-249	165*	48	7.9		
	III	250-299	400	36	14.4		
	IV	300-349	681	6	4.1		
	V	350-399	1500	6	9.0		
	Total			101	35.7	1.4	3.7

Appendix B (Continued)

Species	Age Class	Size (mm)	Average Weight (g)	Total Number	Total Weight (kg)	Percent Total Number	Percent of Total Weight
White Sucker	I	150-249	180*	16	2.8		
	II	250-324	425	187	79.5		
	III	325-374	578	226	130.6		
	IV	375-424	667	236	150.7		
	V	425-474	950	43	40.8		
Total				708	404.4	9.5	34.2
Yellow Bullhead			432	110	47.5		
Total				110	47.5	1.4	4.0
Total for Pond				7347	1177.0	100.0	100.0

* Weight reported for species size class (Thorn, 1969)